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Y. Watanabe S. Heun G. Salviati  
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# Nanoscale Spectroscopy and Its Applications to Semiconductor Research



Springer

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*Cover Picture:* Secondary electron image of a tetrapod (see figure 4 page 55, contribution of T. Sekiguchi in this volume)

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## Preface

This book contains the invited and contributed papers presented at the International Workshop on *Nanoscale Spectroscopy and Its Applications to Semiconductor Research* which was held in Trieste, December 11–14, 2000.

Nanostructured semiconductor materials with dimensions less than the de Broglie wavelength of electrons are expected to exhibit quite different electronic properties from those of common three-dimensional devices. The fabrication technologies for nanostructured devices have been developed only recently, and the electrical and optical properties of such nanostructures are still the subject of advanced research. However, classical spectroscopic techniques cannot be applied to these structures because their lateral resolution is not sufficient to resolve the structures.

Bearing that in mind, the workshop was aimed at comparing and discussing different approaches to spectroscopic microscopy, like electron beam probe spectroscopy, spectroscopic photoelectron microscopy, and scanning probe spectroscopy, in view of their application to nanostructured semiconductor materials and devices. In this respect, it was decided to collect the papers in homogeneous groups characterized by the spectroscopic technique employed, in order to better show the limits and possibilities of the different experimental approaches.

Finally the editors would like to thank the Italian National Research Council (CNR) and the Japan Society for the Promotion of Science (JSPS) for the financial support of the workshop. Thanks are also due to the Abdus Salam International Centre for Theoretical Physics (ICTP) for hosting the scientific sessions.

Parma, Italy  
November 2001

*G. Salviati*  
*Workshop Chairman*

## Acronyms

CBED	Convergent Beam Electron Diffraction
CL	Cathodoluminescence
CTEM	Conventional Transmission Electron Microscopy
EELS	Electron Energy Loss Spectroscopy
ESD	Electron Stimulated Desorption
ESRF	European Synchrotron Radiation Facility
FA	Fluorescence Analysis
FEM	Field Emission Electron Microscopy
FTIR	Fourier Transform Infrared Spectroscopy
HBT	Hetero Bipolar Transistor
HEMT	High Electron Mobility Transistor
HOPG	Highly Oriented Pyrolytic Graphite
HRTEM	High Resolution Transmission Electron Microscopy
LEEM	Low Energy Electron Microscopy
MAES	Metastable-Atom Electron Spectroscopy
MEEM	Metastable Electron Emission Microscopy
MEM	Mirror Electron Microscopy
OBIC	Optical Beam Induced Current
PEEM	Photoemission Electron Microscopy
PES	Photoelectron Spectroscopy
PLI	Photoluminescence Imaging
REM	Reflection Electron Microscopy
RHEED	Reflection High Energy Electron Diffraction
SAM	Scanning Auger Microscopy
SCL	Spectrally Resolved Cathodoluminescence
SEAM	Scanning Electron Acoustic Microscopy
SEM	Scanning Electron Microscopy
SNOM	Scanning Near Field Optical Microscopy
SPEEM	Scanning Photoemission Electron Microscopy
SPELEEM	Spectroscopic Photoemission and Low Energy Electron Microscopy
SPEM	Scanning Photoelectron Microscopy
STEM	Scanning Transmission Electron Microscopy
STM	Scanning Tunneling Microscopy
STS	Scanning Tunneling Spectroscopy
STXM	Scanning Transmission X-ray Microscopy

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SXTM	Scanning X-ray Transmission Microscopy
TED	Transmission Electron Diffraction
TEM	Transmission Electron Microscopy
TXM	Transmission X-ray Microscopy
XMCD	X-ray Magnetic Circular Dichroism
XPEEM	X-ray Photoemission Electron Microscopy
XPLEEM	X-ray Photoemission and Low Energy Electron Microscopy
XPS	X-Ray Photoelectron Spectroscopy

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